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Evaluation of an Individualized Remedial Program
in Arithmetic Problem Solving at 6th Grade Level.

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Chapter I

THE PROBLEM

The purpose of this study is to evaluate the effect of an individualized diagnostic and remedial program in arithmetic problem solving applied to a group of low mental ability and to a group of average mental ability at the sixth grade level. The remedial work stressed having pupils determine the mathematical grouping structure of the problem and then having them understand the appropriate arithmetic process to apply to that particular grouping structure. The students involved were those who were having difficulty in the classroom when solving verbal problems in arithmetic but who were not having serious trouble with reading or arithmetic computation.

Place of Problem Solving in Arithmetic

Before attempting to carry out and evaluate a diagnostic and remedial program in arithmetic problem solving the writer first sought the answer to the question, "What is the place of Problem Solving in arithmetic?"

There seems to be general agreement that the ability to solve problems has an important place in the daily school and post-school life of children, but one of the basic arguments is where problem solving fits into

the school arithmetic program. In 1927 Morton summed up the thoughts of one group when he wrote:

> We teach arithmetic in order that our pupils may be able to solve the problems which they encounter in their school days and in their post-school experiences. To solve problems, one must be proficient in the fundamental operations. But skill in adding, subtracting, multiplying, and dividing are not ends in themselves; they are merely the means to an end. The end is the ability so solve problems which one meets and the fundamental skills are the tools with which one works. The fundamental skills are important; good tools are always important. But we should not let our enthusiasm for training pupils in the fundamental skills blind us to the fact that the principal purpose of arithmetic instruction yet remains to be accomplished. Skill in solving problems is the main thing.[1]

In recent years the point of view that problem solving as such is <u>the</u> important ability in arithmetic has been challenged by many including Spitzer who wrote in 1948:

> While the ability to solve problems is an important aspect of arithmetic, it is doubtful whether the skill should be set up as a separate objective, the end of all instruction in the fundamental processes. Rather than being considered as something separate from other phases of arithmetic, problem solving should be an integral part of the total program. For example, in teaching the multiplication process, problems were used in illustrating the procedure, in showing the significance of the multiplication process after it was mastered, and in review and test exercises of the multiplication process. Every modern textbook makes use of problems in these ways.[2]

If we are going to approach the teaching of arithmetic problem solving through the study of the mathematical grouping structure of a problem situation , then problem solving must be an integrated functional part of the total arithmetic program.

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[1]Robert L. Morton, <u>Teaching Arithmetic in the Intermediate Grades</u> (Silver Burdett and Company, 1927), p. 295.

[2]Herbert F. Spitzer, <u>The Teaching of Arithmetic</u> (Boston: Houghton Mifflin Company, 1948), pp. 209-210.

Chapter II

REVIEW OF RESEARCH AND LITERATURE

Research

No evidence has been found by the writer that previous research in remedial work in problem solving has used the mathematical grouping structure of the problem as a basis for instruction. However, it has been necessary to investigate some of the studies done in the past as a means of comparison of techniques and to help substantiate the claim that there is need for further study and investigation in this particular field.

In an introduction to a report on his study of arithmetic problem solving in 1922 Banting[1] observed that what meager literature there was on the subject of problem solving was general in character and scientific in language. He felt that this type of writing was of little value to classroom teachers. Banting realized that there was a need for definite concrete material to help those who were having difficulty in solving arithmetic problems. This prompted him to initiate and supervise a

[1]E. L. Merton and G. O. Banting, "Remedial Work in Arithmetic," Second Yearbook, Department of Elementary School Principals (Washington, D. C.: National Education Association, 1923), pp. 395-421.

cooperative study in the Waukesha Elementary Schools. The purpose of the study was to isolate and remedy the difficulties in arithmetic reasoning in that school system.

The procedure in Banting's investigation was to analyze the results of the Buckingham and Monroe tests which had been administered to the students used in the program and to study the daily work of those pupils. From these analyses the investigator listed fourteen causes of failure in solving arithmetic problems. He labeled his fourth cause as the most important consideration:

> IV. Lack of ability to identify the proper process or processes with the situations indicated in the problem. One may understand the processes very well and yet not know which to choose to solve a particular concrete problem. The lack of this ability, not to know whether to add, subtract, multiply, or divide in a concrete case is characteristic of so-called dull pupils in arithmetic, and is the chief cause of the painful stabbing, the mere juggling with figures that is the despair of the teacher in the middle and upper grades.[2]

Banting is of the opinion that if the pupil does not acquire the ability to connect the situation with the proper process in the lower grades he is a helpless failure in upper grade arithmetic.

In his suggestions for remedial work Banting stated that no clues or rules should be taught except in the case of some dull pupils who can never be taught to reason effectively. A method which Banting found useful was oral analysis of the student's work procedure and individual remedial work to remedy the difficulties discovered.

In 1925 Stevenson[3] reported on a study carried out to aid pupils in

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[2] Banting, Op. Cit., p. 412.

[3] P. R. Stevenson, "Difficulties in Problem Solving," Journal of Educational Research, 11: 95-103 (February, 1925).

their ability to solve arithmetic problems. He listed six causes of failure found in his study:

(1) Physical defects
(2) Lack of mentality
(3) Lack of skill in fundamentals
(4) Inability to read
(5) Lack of general and technical vocabulary
(6) Lack of proper methods or technique for attacking problems[4]

His remedial measures proved effective in the study. They are:

> I. Teach pupils to read problems and develop a technique for working them. When assigning the lessons have the pupils read the problem silently and teach them to pick out (1) what they are asked to find out, (2) what is given to help answer the question, (3) what process or processes are to be used, and (4) instruct them to estimate answers... .
>
> II. Teach them the vocabulary used in problems... .
>
> III. Dramatize the problems referring to measurements, e.g., pints, quarts, inches, feet, area, etc.
>
> IV. Give a large variety of problems from life situations... .[5]

The above formal analysis type of teaching arithmetic problems does not elaborate on the very important point of how pupils are to determine what process or processes should be used. Stevenson suggests this as a third step in his approach but offers no concrete suggestions as to how it should be taught.

A study to determine why pupils make mistakes in solving arithmetic problems was carried out by Chase[6] in 1929. He believed that the mistakes and errors which pupils are commonly observed to make are merely symptoms and seldom constitute the true causes or mental maladjustments responsible

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[4] Stevenson, _Op. cit._, p. 95.

[5] Stevenson, _Op. cit._, pp. 102-103.

[6] V. E. Chase, "The Diagnosis and Treatment of Some Common Difficulties in Solving Arithmetic Problems," _Journal of Educational Research_, 20: 335-342 (June- Dec. 1929).

for difficulty or failure. Using seventeen students from the Junior High Schools in Fordson, Chase made a very detailed study of each employing the techniques of the case history, standardized tests in fundamentals and reasoning and stenographic records of oral interviews and diagnosis. The results of his study showed that the lack of sufficient mastery of the fundamentals was a common cause of difficulty in solving verbal problems. Chase also found that half the cases could not tell which process to apply in the solution of the problems. Urging systematic study and diagnosis of individual difficulties, Chase concluded that this corrective treatment might profitably fit into the school instructional methods.

A program of diagnostic and remedial work in arithmetic problem solving was conducted by Rolker[7] in the Baltimore public schools in 1931. The scope of the study was such that no individual measures were employed. The children were grouped according to needs determined from results of the Buckingham Scale for Problems in Arithmetic and the Stevenson Arithmetic Reading Test. The pupils having low scores on the section of the Stevenson test which required them to determine "Facts Given" were given special types of exercises to increase their ability to find the stated facts in the problems. The teachers in the system evolved several new types of exercises and tests and used them in group remedial work. They included multiple-choice tests on technical terms, matching games for terms, tests to help associate the process with terms, and exercises to assist children to see the relation between the steps called for in the solution of problems. The pupils were then given fifteen weeks of two forty-minute periods per week instruction in arithmetic problem solving involving the special

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[7]Edna Rolker, "Arithmetic Problem Solving," _Tenth Yearbook, Department of Elementary School Principals_ (Washington, D. C.: National Education Association, 1931), pp. 471-475.

exercises cited above. Rolker then had the students re-tested. The group re-tested by the Stevenson Arithmetic Reading Test showed an average gain of one and one-half years. The re-test on the group using the Buckingham Scale for Problems in Arithmetic showed a similar gain. Rolker stated that some of the practice exercises were modeled after those found in the standard tests used. It would appear that the teaching was directed towards obtaining good test scores rather than towards a gain in the reasoning abilities of the pupils. However, one positive outcome of the program was that the teachers became more critical of their teaching of problem solving.

The research reported in this chapter reveals that the investigators have not dealt with the mathematical aspect of problem solving. That is, they have not had pupils become competent in the understanding of the grouping structures which are basic to the application of the fundamental processes. Banting's cues for dull pupils, Stevenson's formal analysis approach and Rolker's teaching for the test method do not make provision for the fundamental difficulties pupils have in trying to abstract the grouping situation in the problem and applying the appropriate process to the grouping situation.

Suggestions from the Literature

No evidence has been found by this investigator of any theoretical discussion of the grouping structure approach in teaching arithmetic problem solving. However, a point of view in remedial instruction in arithmetic expressed by Brownell in 1929 is similar in nature. He states:

> The teacher, in presenting each new number fact, is careful

> to develop its meaning from what is already known, and she expects the children at first to employ crude procedures and round-about methods in dealing with it. The pupil, in his turn, perhaps at the beginning requires some verification of the fact by counting, then treats it in relation to what abstract facts he already knows, and finally accepts it and learns it by establishing the direct association which he is expected to establish at the very first by drill exponents; and the result of such learning is an integrated whole which possesses meaning and makes possible the intelligent use of its component parts.[8]

The remedial instruction in the present investigation is based on teaching meaningful arithmetic. Brownell describes meaningful arithmetic as "instruction which is deliberately planned to teach arithmetical meanings and to make arithmetic sensible to children through its mathematical relationships."[9] This type of teaching would tend to develop in the pupil the ability to do what Brueckner and Grossnickle call "quantitative thinking."[10] The pupil would be lead to think through the problem situation without depending upon word cues, memory of types or guesswork.

Featherstone has this to say concerning meaningful arithmetic and slow learners:

> Arithmetic can have a body of meaningful, functional, social content by itself if one is careful to apply the same kind of standards in selecting that content which one uses in selecting the content of the major units or the content of reading. Failure to apply such standards in the past, coupled with failure to teach arithmetic understanding explains why so many slow learners in innumerable schools have had a difficult time with the subject

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[8]William A. Brownell and others, Remedial Cases in Arithmetic. Reprinted from the Peabody Journal of Education, VII: 2,3, 4, 5, 6: 5, 6. (1929 -1930)

[9]William A. Brownell, "The Place of Meaning in the Teaching of Arithmetic," Elementary School Journal, 47: 256-265 (January, 1947).

[10]Leo J. Brueckner and Foster E. Grossnickle, How to Make Arithmetic Meaningful , Philadelphia: The John C. Winston Company, 1947, p. 434

> One cannot make arithmetic a matter of animal training--of hair-trigger responses to number cues and quantitative situations that are not understood.[11]

Although a review of the previous research indicates that no studies have dealt with the mathematical aspect of problem solving, the writers in this field have urged the teaching of this meaningful approach to arithmetic problem solving. This leads the present investigator to assume that a study involving the grouping structure approach to understanding arithmetic problems is both necessary and purposeful at the present time.

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[11] W. B. Featherstone, Teaching the Slow Learner, New York: Bureau of Publications, Teachers College, Columbia University, 1941, pp. 84-85.

Chapter III

Procedure of the Study

Introduction

The purpose of this study is to evaluate a program of individualized remedial instruction in arithmetic problem solving at the sixth grade level. The instruction was based on developing an understanding of the mathematical grouping structures in problem situations and helping pupils to recognize the appropriate processes for various grouping structures.

Selection of Pupils

The two groups of pupils of low and normal mental ability which were used in this study were chosen from sixth-grade classes in two elementary schools in Brockton, Massachusetts.

Low mental ability group

Ten sixth grade students were selected by the principal and the sixth grade teacher of the Sprague School as those having the most difficulty in their classroom work in arithmetic problem solving. Only five of these pupils were to be given the individual remedial instruction.

A series of tests was administered to this group of ten. The tests

given were the California Test of Mental Maturity (Short Form), The Progressive Arithmetic Reading Test, Form A, and the Carter Non-Computational Arithmetic Problems Test. The testing served two purposes: (1) to aid in the final selection of the five students, and (2) to furnish a picture of the initial status of the pupils receiving the instruction.

The five pupils finally selected were chosen for remedial instruction at a conference of the teacher, the principal and this writer. The selection was based on the test scores, the reading ability of the pupils and the general needs of the individual.

Normal mental ability group

Eight pupils from the sixth grade rooms of the Huntington School were suggested by the Educational Consultant of the Brockton Schools and the class teachers as those whose mental ability was normal or above, and yet whose arithmetic problem-solving achievement was low. The same tests were given to this group as to the low mental ability group. Five pupils were selected as a result of this testing program.

This selective process, then, provided two separate groups of five individuals each for remedial instruction. The low mental ability group at the Sprague School had I. Q.'s ranging from 69 - 87, and the average mental ability group at the Huntington School had I. Q.'s ranging from 100 - 108.

Diagnostic Procedure

The diagnosis of the pupils was a continuous process starting with the initial testing program and continuing right through the remedial

lessons. The work habits and attitudes were observed and recorded during the testing periods. The tests were then examined to find special weaknesses in any of the fundamental processes. Before the remedial program was begun, each pupil was orally interviewed and these interviews were carefully analyzed. The interview was designed to accomplish three purposes: (1) to establish a friendly atmosphere of informality between the pupil and the instructor, (2) to check the reading ability of the pupil, and (3) to determine what method or methods the pupil had been using to solve various problem situations.

During the interview each pupil was asked to read aloud and then solve or attempt to solve a set of arithmetic problems. The problems required the use of the different fundamental processes for solution. No attempt was made during the interview to direct the efforts of the pupils to think through the problem. The emphasis was on finding out what was going on in the thought patterns--not to change them. The pupil was constantly asked to tell why he did a certain problem a certain way. Every effort was made to discover what methods the pupil was using to solve the problem.

During the remedial program the diagnosis was continued. Because the work was individual it was possible for the instructor to observe constantly the changes in work habits that took place. This enabled him to keep the instruction geared to fit the needs of the individual.

The Remedial Program

Each pupil was given individual instruction twenty minutes a day for fifteen successive school days. All of the remedial work was carried out during the morning sessions of the schools--the investigator spending

fifteen successive school mornings in one school, then fifteen in the other. The speed and personal work habits of the individual were taken into consideration in the lesson planning. The two schools provided rooms containing a table and chairs. The ventilation and lighting were adequate.

The remedial instruction was based on the theory that if more of the mathematical meanings in arithmetic are developed through the employment of concrete objects, then the pupil will be prepared to solve the problems in arithmetic with a greater degree of understanding.

The initial phase of the remedial work was concerned with the grouping structure upon which our number system is built. The pupils were urged to use sticks and other objects for counting purposes to develop the true meanings of the numbers. For instance, the number 15 would be developed as one group of ten and five ones. This type of thinking not only helps to teach the meanings of the number system, but also builds a foundation for thinking through the grouping structures of the fundamental processes. The consideration of the grouping structures of the fundamental processes was the second step in the remedial instruction. The following grouping structures were considered:

1. Addition is used to:

   Combine two or more groups in order to find the size of the total group.

2. Subtraction is used to:

   (a) Find out how many more or how many fewer there are in one group than in the other.

   (b) Find out how much is left or gone when we take a sub group away from the total group.

   (c) Find out how many must be added to a group to make it equal

to a larger group.

3. Multiplication is used to:

   Find the size of the total group when two or more groups of equal size are to be combined.

4. Division is used to:

   (a) Find how many times a unit group is contained in a total group.

   (b) Find the size of each group when a total group is divided into a certain number of equal groups.

The aim of the type of instruction used in this study was to develop in the pupil the ability to read the problem, determine the grouping structure which was described and then solve the problem. At first the pupil was encouraged to use small sticks and cardboard circles to represent units in the problem. By combining these concrete objects and manipulating them according to the requirements of the problem the pupil was able to see the group situation clearly and thus better see the application of the fundamental processes. Each problem was presented to the pupil on a three-by-five card and he was asked to read the problem aloud so reading difficulties could be controlled. The problems used at this point of instruction were selected carefully so that small numbers were used.

An example:

1. A farmer has 14 horses. He sells 8 of them. How many horses does he have after the sale?

After reading the problem, the student would represent the fourteen horses with match sticks as one group of ten and four more horses. Then he would "sell" eight of the horses or sticks to the instructor by giving

him the four horses not grouped along with four horses from the group of ten. He would then discover by counting or observation that he had only six horses left. Although the pupil began by letting sticks represent objects in the problem, the idea of the sticks as units and groups of units was brought out. The sticks did not have to stand for anything in particular.

After varied practice with the sticks which lasted for varying periods of time depending on the individual's ability to grasp the grouping structure, the use of marks on paper was introduced. Instead of grouping the sticks as directed by the problem, the pupil was asked to represent the units with marks on the paper. Grouping was accomplished by circling the proper number of marks. If the pupil was unable to represent the units with marks on the paper properly, he was urged to use the sticks again. After proper grouping was arrived at with the sticks, the marks were brought into use again. After varied practice with marks the pupil was asked to think through the problem and solve it without the aid of the sticks or the marks. The transfer from the concrete to the abstract was an important phase of the instruction. When solving any problem during the remedial instruction the pupil was urged to write down on the paper the process which he had identified as appropriate for the grouping structure described in the problem.

Evaluation of the Remedial Program

After the pupils had had the fifteen periods of instruction, tests were again administered to obtain an objective evaluation of growth. Form B of the Progressive Arithmetic Reading Test was given and the

Carter Non Computational Arithmetic Problems Test was re-administered. Since the Carter Test had not been seen again by the pupils after it was administered during the pre-remedial period, and since none of the problems from the test were used in the remedial instruction, it was felt that re-giving the test would be fair to the pupils and to the needs of the study.

Approximately two months after the final tests were given by the investigator, the Stanford Achievement Test was administered to all of the sixth grade pupils in the Brockton Schools. The arithmetic test scores for the pupils used in this study were obtained from the office of the Educational Consultant. These scores were used as a measure of the continued effectiveness of the remedial program.

In addition to the objective evaluation, provision was made for some subjective evaluation. Continued observations were made by the investigator throughout the remedial period of pupil behavior, and the teachers also noted behavior when the subjects were in their regular classrooms.

Chapter IV

ANALYSIS OF RESULTS

Introduction

The evaluation of this remedial program was on a two-fold basis. First, objective evidence was obtained for comparison of the pupil's status before and after the remedial instruction. Second, subjective evaluations of individual progress were made by the investigator and the classroom teachers.

Objective Evaluation

Pre-Remedial Status

The initial status of the pupils' ability in arithmetic was obtained during the selection of pupils for remedial instruction.

Table I shows the initial status of the Shaw School pupils--the low mental ability group. This status was determined at the time that these pupils were in the sixth month of the sixth grade. The information in the table was obtained through the administration of the New California Short Form Test of Mental Maturity Elementary '47 S-Form, The Carter Non-Computational Test of Arithmetic Problems, and The Progressive Arithmetic Reading Test (Form A). The mental ages and chronological ages are given in years

and months. The Carter Test score indicates the number of correct answers made out of 50 possibilities. The Progressive Arithmetic Test results are given as grade scores. The capital letter S preceding the pupil's number stands for Shaw School. S-1 through S-5 inclusively are the pupils of this group who were given remedial instruction. Pupils S-6 through S-10 were not given remedial instruction.

TABLE I

INITIAL STATUS IN ARITHMETIC OF THE LOW MENTAL ABILITY SIXTH-GRADE GROUP

Pupil	Sex	M.A.	C.A.	I.Q.	Carter Score[1]	Progressive Arithmetic Scores		
						Reasoning[2]	Fund.[2]	Total[2]
S-1	F	10-11	13-11	78	20	6.0	5.8	5.9
S-2	F	9-7	11-6	85	25	5.0	6.1	5.9
S-3	M	11-9	13-6	87	21	5.0	6.6	6.2
S-4	F	9-2	12-1	76	18	3.6	5.7	4.8
S-5	M	9-9	14-2	69	15	5.7	6.3	6.2
S-6	M	9-11	11-8	85	17	5.5	6.0	5.9
S-7	F	11-11	13-3	90	23	6.4	6.7	6.6
S-8	F	12-7	13-7	93	21	6.5	6.5	6.5
S-9	M	11-9	12-10	92	21	4.9	6.3	6.0
S-10	F	12-8	12-11	92	20	4.3	4.1	4.2

[1]Number correct out of the fifty items.
[2]Grade scores.

Table I would be read as follows:

Pupil S-1, a girl, has a mental age of 10 years, 11 months, a chronological age of 13 years, 11 months and a computed intelligence quotient of 78. She had 20 correct answers on the Carter Test out of a possible 50. Her Progressive Arithmetic scores indicate grade placements of 6.0 in reasoning, 5.8 in fundamentals and a total score of 5.9.

The five pupils (S-1 through S-5) selected from the low mental ability group for remedial instruction have I.Q.'s ranging from 69 to 87 with a group average of 79. The scores on the reasoning section of the Progressive Arithmetic Test indicate that none of these pupils achieved up to the 6.6 level which would be considered average for the end of February in the sixth grade. The Carter Test scores are all below the 30 correct answers found to be average for sixth grade pupils by Carter in his study.

Pupils S-6 through S-10 did not receive any remedial instruction but the results are shown throughout the testing program to serve as a comparison group. Since it was impossible to equate the pupils in the two groups these pupils will be referred to as the comparison group rather than the control group.

Table II shows the initial status in arithmetic ability of the normal mental ability group from the Huntington School. This group was given the same tests as the low mental ability group, i. e., The New California Short Form Test of Mental Maturity Elementary '47 S-Form, The Carter Non-Computational Test of Arithmetic Problems, and the Progressive Arithmetic Reading Test, Form A. As in Table I the Carter Test scores are the number correct out of a possible 50 and the Progressive Arithmetic Test results are shown as grade placement scores. The letter H preceding the pupil's number is used to identify the pupil as being from the Huntington School

and in the normal mental ability group.

There were individual Binet intelligence test scores available for three of these pupils at the Child Guidance Center in Brockton. These are shown in the column labeled Binet Score. The Binet Scores are included to show that the I.Q.'s obtained by the California Test of Mental Maturity (a group test) are fairly comparable to the Binet results.

TABLE II

INITIAL STATUS IN ARITHMETIC OF THE NORMAL MENTAL ABILITY GROUP

Pupil	Sex	M.A.	C.A.	I.Q.	Binet Score	Carter Score	Progressive Arith. Scores Reasoning	Fund.	Total
H-1	M	12-10	12-2	105	111	27	6.4	6.5	6.5
H-2	M	11-11	11-3	106	103	17	4.7	4.3	4.5
H-3	M	12-7	11-11	106	110	37	6.9	7.0	7.0
H-4	F	11-9	11-9	100		17	7.2	6.7	6.8
H-5	M	12-8	11-9	108		25	5.7	5.5	5.6

The data in Table II reveal that the normal mental ability group had computed I.Q.'s ranging from 100 to 108 with a group average of 105. The Carter Test scores vary from 13 below to 7 above the criterion score of 30. The Progressive Arithmetic Reasoning Test scores show a wide variance of from 4.7 to 7.2 years.

There is no comparison group for the normal mental ability group.

Changes During the Remedial Period

After the fifteen periods of remedial instruction the Progressive Arithmetic Reading Test, Form B, was given to the students and the

Carter Test was re-given. In Tables III and IV, the scores received on these tests are compared to the scores received during the initial testing period.

Table III shows a comparison of scores made by the low mental ability group on the Carter Test and the Progressive Arithmetic Reading Test before and after remedial instruction.

TABLE III

PRE-TEST AND FINAL TEST SCORES FOR LOW MENTAL ABILITY PUPILS: CARTER TEST AND PROGRESSIVE ARITHMETIC TEST

	Remedial group					Comparison group				
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10
CARTER										
Pre-test	20	25	21	18	15	17	23	21	21	20
Post-test	34	21	20	18	19	18	24	22	24	25
Gain	14	-4	-1	0	4	1	1	1	3	5
PROGRESSIVE REASONING										
Pre-test	6.0	5.0	5.0	3.6	5.7	5.5	6.4	6.5	4.9	4.3
Post-test	7.6	5.4	6.5	4.6	6.5	5.5	6.9	5.9	5.7	6.7
Gain	1.6	.4	1.5	1.0	.8	0	.5	-.6	.8	2.4
PROGRESSIVE COMPUTATION										
Pre-test	5.8	6.1	6.6	5.7	6.3	6.0	6.7	6.5	6.3	4.1
Post-test	6.5	6.3	6.3	6.0	6.3	5.8	7.1	6.5	6.7	5.8
Gain	.7	.2	-.3	.3	0	-.2	.4	0	.4	1.7
PROGRESSIVE TOTAL										
Pre-test	5.9	5.9	6.2	4.8	6.2	5.9	6.6	6.5	6.0	4.2
Post-test	6.7	6.1	6.4	5.6	6.4	5.7	7.1	6.3	6.3	6.1
Gain	.8	.2	.2	.8	.2	-.2	.5	-.2	.3	1.9

For the Carter Test the scores show that pupil S-1 was the only subject who had an important gain. It may well be that the Carter Test was still too hard for these pupils even though they showed a gain in reasoning ability. The reasoning section of the Progressive Arithmetic Test is the most vital part of Table III. All the remedial instruction was aimed at improving the reasoning ability of the pupils. Pupils S-1 through S-5 have gains in reasoning scores of from .4 years to 1.6 years with an average gain of 1.06 years, and this as a result of a three week remedial program. Pupils S-6 through S-10 show an average gain in reasoning scores of .6 years. However, this average is influenced greatly by Pupil S-10's score. Pupil S-10 had a gain in reasoning score of 2.4 years. Her very poor scores on the initial test plus the fact that her I.Q. was computed to be 92 (Table I) suggest that Pupil S-10 may have not performed at par when the first tests were given. The classroom teacher did not observe any such marked improvement in the class work of Pupil S-10.

On the total scores of the Progressive Arithmetic Test the pupils who received remedial instruction (S-1 through S-5) had an average gain of .4 years. Pupils S-6 through S-10 did not receive remedial instruction but they displayed a similar average gain of .4 years. Again, however, this average is affected by Pupil S-10's gain which was 1.9 years.

Table IV shows the scores for the normal mental ability group on the pre-experimental and post-experimental tests.

TABLE IV

PRE-TEST AND FINAL TEST SCORES FOR NORMAL MENTAL ABILITY PUPILS: CARTER TEST AND PROGRESSIVE ARITHMETIC TEST

	H-1	H-2	H-3	H-4	H-5
CARTER					
Pre-test	27	17	37	17	25
Post-test	35	17	41	23	38
Gain	8	0	4	4	13
PROGRESSIVE REASONING					
Pre-test	6.4	4.7	6.9	7.2	5.7
Post-test	7.2	7.2	7.4	6.7	5.9
Gain	.8	2.5	.9	-.5	.2
PROGRESSIVE COMPUTATION					
Pre-test	6.5	4.3	7.0	6.7	5.5
Post-test	6.5	5.9	8.1	7.3	6.8
Gain	0	1.6	1.1	.6	1.3
PROGRESSIVE TOTAL					
Pre-test	6.5	4.5	7.0	6.8	5.6
Post-test	6.7	6.2	8.0	7.2	6.5
Gain	.2	1.7	1.0	.4	.9

The scores from the Carter Test reveal that four of the five pupils improved on this test during the remedial period. The average gain was 5 answers. It should be noted that after the remedial instruction three of this group were well over the arbitrary standard of 30 correct answers out of 50 as proposed by Carter. Thus, while the low mental ability group did not improve on the Carter test after the brief three week remedial program, this period of training did seem to improve the scores of the average mental ability pupils on this test.

The scores from the reasoning section of the Progressive Arithmetic Test vary from a loss of .5 years to a gain of 2.5 years. The average gain is .78 years for the group and this was after a three week period of remedial instruction. Although the remedial work was directed on improving reasoning ability in arithmetic, the computation scores of three of this group showed gains of over one year. The total scores show gains of from .2 years to 1.7 years with an average gain of .8 years.

Tables III and IV indicate that there was definite improvement in the reasoning scores of the Progressive Arithmetic Test for both the low and the normal remedial groups. The low mental ability group indicated an average gain of 1.06 years in arithmetic reasoning scores while the normal mental ability group showed an average gain of .78 years in arithmetic reasoning scores.

Evidence of Maintenance of Gain

The Stanford Achievement Test was administered to all sixth-grade pupils in the Brockton Schools two months after the final tests were given in this remedial program. The scores from the arithmetic section of the Stanford Test were obtained for the pupils who participated in this program. Tables V and VI compare the Stanford results with the previously reported scores for the Progressive Arithmetic Test. Because norms from the Stanford Test and the Progressive Test are probably not directly comparable, no definite inferences as to specific amounts of gain or loss can be drawn from these tables. However, the Stanford results do give an indication of the permanence of the effects of the remedial program.

Table V shows the scores from the Stanford Achievement Test (arithmetic section) and those from the Progressive Arithmetic Test for the low mental ability group.

TABLE V

ARITHMETIC REASONING AND FUNDAMENTALS SCORES FROM THE PROGRESSIVE TEST AND THE STANFORD ACHIEVEMENT TEST FOR THE LOW MENTAL ABILITY GROUP

	Arithmetic Reasoning			Arithmetic Fundamentals		
	Progressive			Progressive		
Pupil	Pre-test	Post-test	Stanford	Pre-test	Post-test	Stanford
S-1	6.0	7.6	6.8	5.8	6.5	7.7
S-2	5.0	5.4	6.0	6.1	6.3	5.8
S-3	5.0	6.5	5.6	6.6	6.3	7.3
S-4	3.6	4.6	3.8	5.7	6.0	6.8
S-5	5.7	6.5	7.1	6.3	6.3	7.0
S-6	5.5	5.5	7.1	6.0	5.8	7.1
S-7	6.4	6.9	6.5	6.7	7.1	8.3
S-8	6.5	5.9	5.7	6.5	6.5	7.5
S-9	4.9	5.7	7.1	6.3	6.7	6.6
S-10	4.3	6.7	5.7	4.1	5.8	7.0

In Table V we find that the pupils in the experimental group (Pupils S-1 through S-5) show a gain in reasoning ability which is substantiated by both the post-experimental administration of the Progressive Test and the later Stanford Achievement Test. This gain in reasoning scores is marked in the cases of Pupils S-1, S-2, S-3 and S-5.

In the comparison group (Pupils S-6 through S-10) we find gains in reasoning scores which are substantiated by both tests in only two cases, i.e., pupils S-9 and S-10. Any other gains in reasoning scores for the pupils in the comparison group are indicated on one or the other but not both the Progressive post-test and the Stanford Achievement Test.

The arithmetic fundamentals scores do not show as great a gain for the experimental group as for the comparison group. The explanation for this may be that the experimental group was concentrating on the improvement of

reasoning ability and may not have had as much experience in computing during the three week period.

Table VI shows the results from the arithmetic section of the Stanford Achievement Test and those from the Progressive Arithmetic Test in arithmetic reasoning and fundamentals for the normal mental ability group.

TABLE VI

ARITHMETIC REASONING AND FUNDAMENTALS SCORES FROM THE PROGRESSIVE TEST AND THE STANFORD ACHIEVEMENT TEST FOR THE NORMAL MENTAL ABILITY GROUP

	Arithmetic Reasoning			Arithmetic Fundamentals		
	Progressive			Progressive		
Pupil	Pre-test	Post-test	Stanford	Pre-test	Post-test	Stanford
H-1	6.4	7.2	7.1	6.5	6.5	5.3
H-2	4.7	7.2	4.7	4.3	5.9	5.8
H-3	6.9	7.4	8.8	7.0	8.1	7.5
H-4	7.2	6.7	6.8	6.7	7.3	6.5
H-5	5.7	5.9	9.0	5.5	6.8	8.1

Table VI indicates a gain in reasoning scores for three of the pupils (H-1, H-3 and H-5) which is substantiated by both the Progressive post-test and the Stanford Achievement Test. The scores for Pupil H-2 show more about his work habits than his understanding of arithmetic. In the pre-test he has a grade score of 4.7 years in arithmetic reasoning before remedial instruction. During the remedial program it became evident that when this pupil worked under continued urging and prompting he could reason quite well. During the administration of the Progressive Test immediately following the remedial instruction Pupil H-2 was constantly urged to keep

working. His resulting score was 7.2 years. When this same pupil took the follow-up Stanford Test, he was allowed to work at his own pace, and his score went back down to 4.7 years.

Although the instruction in the remedial program was for the improvement of the reasoning ability of these pupils, the fundamentals section scores show substantiated gains for three of the five pupils.

Tables V and VI have indicated that the remedial instruction resulted in more substantiated gains in reasoning scores for the low mental ability experimental group than for the individuals in the normal mental ability group.

INDIVIDUAL SUBJECTIVE EVALUATION

Low Mental Ability Group

Pupil S-1 was a tall, awkward girl fourteen years of age. She was a willing worker during the remedial instruction periods and expressed a desire to have the program continue. This may have been because the remedial work offered her a chance to be away from the class for twenty minutes a day. From her conversation it appeared that she felt ashamed of still being in the sixth grade. On any problems concerning money and buying she did very well because she had had considerable experience in shopping for food. Her interests centered around the home--helping with the housework and taking care of the younger children.

One of her areas of inability in arithmetic problems was multiplication. She repeatedly attempted to multiply by adding. The grouping structure for which the multiplication process is appropriate was stressed and this difficulty was overcome. Her vocabulary was limited, and considerable

care was taken to keep the problems within her vocabulary range during the remedial work.

S-1 showed the most improvement of any of the low mental ability group. Her attitude throughout the program made it a pleasure to work with her.

Pupil S-2, a small frail girl with a C.A. of 11-6 and an I.Q. of 85, seemed to lack the physical vitality necessary for concentrated work in school and this inability to concentrate affected the attempts to remedy her difficulties. Rather than applying her thoughts to a problem, she would say that she didn't know how to do it.

During the diagnosis it was observed that she leaned heavily on cues. Anytime that she saw three or more numbers in a problem she added. A problem containing two numbers of the approximate same size meant that she would try both subtraction and multiplication and use one of the resulting numbers for an answer. If the problem contained one small and one large number she divided.

S-2 enjoyed the initial phases of the remedial instruction, and handling the sticks helped her to concentrate on the problems. Although progress was very slow, she solved the various grouping situations with the sticks. Transfer of this ability from the concrete to the abstract was not accomplished and she continued to rely upon the use of sticks.

The investigator questions whether it would be advantageous to attempt further remedial work with S-2 unless her physical condition was improved.

Pupil S-3, with a C.A. of 13-6 and an I.Q. of 87, displayed indifference and shyness at the first interview. His interest in fishing was far greater than his interest in school. When the conversation came around to fishing, he lost both his indifference and his shyness and became

an altogether different individual. A series of problems was constructed containing fishing incidents and S-3 learned the grouping structure manipulations readily.

His most important difficulty was a confusion of the multiplication and division processes. By stressing the differences in the grouping structures for these two processes, the investigator was able to clear up this difficulty. The transfer from the use of sticks to the use of marks on paper was good and S-3 became entirely independent of sticks. When problems about subjects other than fishing were introduced, he showed a drop in interest but still displayed an ability to solve these other problems. From observation it appeared that he had a far better understanding of the mathematics of arithmetic at the close of the program.

Pupil S-4 was a short, rather chubby girl with a C.A. of 12-1 and an I.Q. of 76. She seemed almost proud of the fact that she couldn't do arithmetic problems. It was difficult, at first, to find where her difficulties were because she claimed that she couldn't solve the simplest problems presented to her. When she did attempt to solve some of the problems, she relied on guesswork and word cues. The remedial work with S-4 was slow. She enjoyed working with the sticks but was very slow to transfer from the concrete to the abstract. The problems used in the remedial lessons for S-4 were very simple. It was felt by the instructor that she would need much more remedial instruction than the fifteen lessons given. Although she did show some improvement, the time limit proposed in this program was inadequate in her case.

Pupil S-5, a large, well-muscled boy with a C.A. of 14-2 and an I.Q.

of 69, was interested more in boxing than in arithmetic. He admitted quite frankly that he could whip any boy in the school, but he did not appear to have the "bully complex." What problems in arithmetic he could solve, he did quickly, but most of his difficulty was with problems requiring division. During the diagnosis he did not attempt to solve any problems which he could not readily work out. He showed high interest when problems involving boxing were used during the remedial instruction. Pupil S-5 showed good spirit and willingness to learn during the instruction periods. His work showed considerable improvement and he attempted and solved many of the problems he could not do before the remedial work.

Normal Mental Ability Group

Pupil H-1 was a small boy with a chronological age of 12 years, 2 months and a computed I.Q. of 105. He was shy and reserved at first. However, he displayed a willingness to work and learn. His work was slowed down somewhat by nearsightedness. Even with glasses he had to get very close to the work at hand. H-1 enjoyed working alone and quickly learned the grouping structures as presented. He liked the work with the concrete objects and the transfer to the abstract was good. It was felt that more individual work would not be advisable in H-1's case because he must learn to work with others. His understanding of the grouping structures of the fundamental processes was very good at the close of the remedial instruction periods. Even with this understanding his shyness would be a detriment in class work.

Pupil H-2 had a chronological age of 11 years, 3 months and a computed I.Q. of 106. He was an unusual boy but one who displayed extremely poor ability to concentrate. Often in the middle of work on a problem he would

suddenly begin a discussion about the Boy Scouts, his bow and arrow or any other of the great variety of things that interested him. Although it was known that he could spend many hours building a delicate model, his whole being rebelled at concentrating on a simple problem. His teachers had worked patiently to try to have him achieve up to what he could do, but all attempts had failed. At first, he was asked to work on one problem at a time. Later in the remedial work the number of problems was increased until he could do four or five problems without stopping. However, when this individual instruction stopped and he went back to the classroom, he was just the same as he was before. He was quick to learn the grouping structures and apply them in solving problems, but the remedial instruction did not get at the basis for his difficulty and solve it. His trouble was his lack of ability to concentrate. In all his tests he usually got most of the problems or examples which he tried. However, this lack of concentration slowed him down so much that he didn't finish enough of the test.

Pupil H-3, a boy with a chronological age of 11 years and 11 months and a computed I.Q. of 106, considered the whole course of remedial instruction too babyish for him. Although his class work had been low and his attitude poor, the initial test scores showed a high degree of achievement. When working alone during the remedial instruction, he displayed an acute sense in solving problems. His thinking was clear and quick. He learned how to solve problems through the understanding and manipulation of the grouping structures, but still maintained an attitude of indifference. When asked why he didn't do better in class, he replied that he could do the work but just didn't feel like it. He demonstrated that he could do the problems during the remedial instruction and in the testing periods.

Pupil H-3's trouble was far deeper within himself than not understanding how to do arithmetic problems.

Pupil H-4, a girl with an I.Q. of 100 and a chronological age of 11 years, 9 months, was the most conscientious worker during the instruction periods. Although she took longer to understand the grouping structure theory, she applied herself to the work eagerly. She talked little at first but later admitted that her one desire in life was to become a model. She didn't like doing problem solving in arithmetic, but she enjoyed working out grouping structures with the sticks. When she realized that she could work out any grouping situation with the aid of sticks or marks on paper she took an entirely different attitude towards problem solving.

During the diagnosis she used cues to aid her in solving problems. Any problem with "how many left" meant subtraction. Problems containing more than two numbers were usually added. She confused subtraction and multiplication processes. However, she had done very well on the initial Progressive Arithmetic Test. It was felt that she gained confidence in herself and a better understanding of problem solving in spite of her lack of gain in the reasoning section of the test.

Pupil H-5, a boy with a chronological age of 11 years, 9 months and an I.Q. of 108, was erratic in mood and work habits. When the spirit moved him, he worked quickly and well. However, at times during the program his whole attitude changed and he became nervous and sulky. This quick change in moods had been previously mentioned by the classroom teacher. She stated that she never knew what to expect from day to day. When H-5 was in a working mood he quickly adapted himself to solving prob-

lems through manipulation of the basic grouping structures. However, on an off-day, he sulked and fretted his way through the lesson. Teaching him during the remedial program was a unique experience. Each day brought in either a personable adept worker or a sulking obstinate person. H-5 did display a sound understanding of the grouping structure of the fundamental processes at the end of the program.

Chapter V

SUMMARY AND CONCLUSIONS

Summary of the Procedure

The purpose of this study was to evaluate the effect of an individualized remedial program in arithmetic problem solving at the sixth-grade level. The instruction was based on developing and understanding of the grouping situations found in problems and using the appropriate fundamental process to solve the particular grouping situation. Two sections of five students each were used in the remedial program. One section was made up of pupils with low mental ability and the other was composed of pupils with normal mental ability. After determining the initial status in arithmetic ability through the administration of the Progressive Arithmetic Test and the Carter Non-Computational Test in Arithmetic Problems, the pupils were given daily individual remedial instruction for fifteen twenty minute periods. The pupils were then re-tested and comparative scores were thus obtained for objective evaluation. Subjective evaluation of the progress of the individual was made by the investigator and the classroom teachers.

Summary of the Results

1. In arithmetic reasoning, the five low mental ability pupils averaged 1.06 years gain in grade score during the three weeks of remedial training. All gains except one were .8 or more. The later measure of retention indicated that this gain was maintained. The low mental ability group did not reveal a gain on the Carter Non-Computational Test.

2. The five pupils of average mental ability had a mean gain of .78 years in grade score on the arithmetic reasoning in the three week remedial period, although one pupil had an actual loss. Four of the pupils had good gains on the non-computational test also. The later retention test indicated the gain was maintained after the remedial program had been discontinued.

3. For the remedial pupils there was some gain in computational achievement, but not to the same extent as in problem-solving ability.

4. The subjective evaluation revealed that the approach to remedial work seemed to be effective.

Conclusions

Low Mental Ability Group

The findings of this study indicate that an understanding of the grouping structures and their appropriate fundamental processes was effected in each individual case in the low mental ability experimental group. This statement is substantiated by the scores for the reasoning section of the Progressive Arithmetic Test and the observations of im-

provement made by the investigator. While the length of the instruction period--twenty minutes--proved to be very desirable for this group, the number of periods, was not adequate in some cases. The number of instruction periods should be determined by the needs of the individual. The Carter Test scores did not show a similar gain in reasoning ability as was indicated in the Arithmetic reasoning scores. This leads the writer to assume that the Carter Test was still too difficult for the low mental ability group even though reasoning ability in arithmetic of these pupils apparently increased.

Normal Mental Ability Group

The objective and subjective data from this study indicate that improvement in arithmetic reasoning ability was achieved by most of the individuals of the normal mental ability group. However, because the difficulties of the individuals in this group seemed largely psychological in nature it is probable that this type of remedial instruction might be most effective if it is included in a remedial program which was planned to study and correct the personality maladjustments of the individuals. Also, there was evidence that the number of remedial instruction periods should be determined by the needs of the individual.

Limitations of the Study

1. The number of remedial instruction periods was set at fifteen daily lessons for each individual when the investigation was planned. This probably was too limited a time for some of the pupils.

2. The experimental group and the comparison group in the low mental ability section were so small (5 individuals each) that they could not

be equated for better objective evaluation of the results.

3. The only indication of maintenance of growth in arithmetic reasoning ability was obtained from a later application of the Stanford Achievement Test. This test was not used in the basic testing program and so no precise comparisons could be made.

4. The size of both experimental groups (5 pupils each) limits the opportunity for the investigator to generalize conclusions.

5. No control was set up which involved other techniques of remedial instruction. Thus it cannot be ascertained whether the approach involving structural grouping or some other factor (e.g., individual help) was the cause of improvement.

Suggestions for Further Study

1. An investigation employing the same remedial techniques using equated experimental and control groups for more specific objective evaluation of results.

2. A study similar to the present one involving more individual cases so that sufficient evidence can be obtained and conclusions generalized.

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DIRECTIONS FOR EXPERIMENTAL TEST

Directions to Teachers-

This test is designed as a non-computational test of ability in problem solving. The pupil is not to work out the problem but merely choose the correct number operation to use in solving the written problem. The pupil will have three possible answers to choose from--if none of the three is the correct answer he is to place an "x" in the parenthesis before the "N."

Directions To Be Read To Pupils-

This is an arithmetic test in which you choose whether you add, subtract, multiply, or divide in solving problems. Write your name, school, and grade in the proper place. (Pause) Look at the directions while I read them aloud.

"After each problem 3 number operations (that means add or subtract, multiply or divide) are indicated. You are to select the one to use in solving the problem. If the correct operation is not given, put an "x" in front of the "N." The sample problems show you how. Look at Sample A now. (Pause)

"What is the correct answer? Yes, $1.00 - $.61 so an "x" has been placed in the parenthesis in front of that response.

"Now look at Sample B (Pause) What is the correct answer? (Pause) The correct answer is not given so an "x" has been placed in front of the "N."

There are 35 questions like these. Then in the second part a different question is to be answered. Read the directions carefully when you come to them. Ready, begin."

Write on the board the beginning time. Then see that the pupils are working correctly. At the end of 20 minutes say, "If you have not already reached problem 36 turn to it now and look at the directions preceding it."

Read aloud these directions: "In this section of the test you are to choose the first number operation to be used in solving the problem. Mark items the same way you did on the preceding section of the test."

Emphasize the part underlined.

"Now go ahead with your work." At the end of 10 more minutes (a total of 30 minutes) say, "Stop. Pass your papers forward."

COPY OF EXPERIMENTAL TEST
by WILLIAM H. CA[illegible]

[illegible] School

[illegible]

[illegible]: [illegible] problem 3 number operations are indicated. [illegible] to use in sol[illegible] the problem. If the [illegible] operation is not given put an [illegible] in front of the N. [illegible] Look at Sample [illegible].

[illegible] paid 61¢ for a not[illegible]. He g[illegible] the clerk [illegible]. How much change should Bill [illegible]ceive?

[illegible] ( ) [illegible].00 x[illegible] (x) $1.00-$.61= ( )N

[illegible] September [illegible] 1947, [illegible] weighed [illegible]6 lb. On [illegible] weighed [illegible] lb. [illegible] much had Nancy gained?

[illegible] ( ) 26-[illegible]= ( ) [illegible]-26= (x)N

[illegible] problem. Remember you do not [illegible] the problem but only [illegible] number operation or "N" if [illegible] correct number operation [illegible].

[illegible] sends him to the dentist twice a year to have his [illegible]. The dentist charges $2.[illegible] each time. How much does [illegible] a year to have Tom's teeth cleaned?

[illegible] ( ) $2.00 ÷ 2= ( ) $2.00 x 2 = ( )N

[illegible], Tom had four teeth [illegible] for $6.00. How much [illegible] charge to fill each to[illegible]?

[illegible] ( ) $6.00-4= ( ) $8.00 ÷ [illegible] ( )N

[illegible] yards of cloth th[illegible] 24 inches wide. [illegible] yards long. How [illegible] the piece that was left?

[illegible] ( ) [illegible]

[illegible] in Lincoln School [illegible] were 459 children. [illegible] girls. How many boys are [illegible]?

[illegible] ( ) 459 + 213 = ( ) 459-12 = ( )N

[illegible] how many pounds [illegible]tatoes can you buy [illegible]?

[illegible] ( ) [illegible] x 6 = ( ) [illegible] ÷ 5 = ( )N

[illegible] costs $[illegible].12. Wh[illegible] the cost of arithmetic [illegible] of 35 children?

[illegible] ( ) $1.[illegible]2 ÷ 35= ( ) $1.12-35 = ( )N

[illegible] last month Jack [illegible] 64 bundles of rags for [illegible]. How much di[illegible] receive for the rags he sold?

[illegible] ( ) 64 x [illegible]5 = ( ) [illegible] x 35 = ( )N

[illegible]

[illegible] to clip the wool from the [illegible] sheep owned [illegible] clipped from [illegible] of the sheep weighed [illegible] pounds [illegible] were clipped from each sheep?
[illegible] ( ) 640-40= ( ) [illegible] ÷ 40 = ( )N

[illegible] speed test held October 20, [illegible] an airplane flew 54[illegible] [illegible] How many miles did the airplane fly in one minute?
[illegible] ( ) 540-60= ( ) [illegible] 60 = ( )N

[illegible] year the fifth grade taken [illegible] reading test. One [illegible] of [illegible] read [illegible] words in three min[illegible] How many words [illegible] minute [illegible] read [illegible] the average?
[illegible] ( ) 540 ÷ 3 = ( ) [illegible] x 3 = ( )N

[illegible] put up [illegible] shelves, each 25 inches long, for his mother. [illegible] board [illegible] he need to cut them [illegible]?
[illegible] ( ) [illegible] 5 = ( ) [illegible] ( )N

[illegible] rope [illegible] is 60 feet long and [illegible] pieces of eq[illegible] length. How long will [illegible] rope [illegible]?
[illegible] ( ) [illegible] x 4 = ( ) [illegible] 4 = ( )N

[illegible] farmer [illegible] cents [illegible] pound for hogs. In 1942 [illegible] per pound. How much more per pound did he [illegible]?
[illegible] ( ) 1942-1921= ( ) 18.[illegible] 13.5 = ( )N

[illegible] family [illegible] use in a year if 25 [illegible]?
[illegible] ( ) [illegible] 12 = ( ) [illegible] 12 = ( )N

[illegible] raised only 12 [illegible] of wheat [illegible] an acre [illegible] This is [illegible] one fourth of the crop [illegible] How many bushels [illegible] does he usually [illegible]?
[illegible] ( ) [illegible] ( ) [illegible] ( )N

[illegible] United States and its possessions is [illegible] The total area of the United States alone [illegible] What is the [illegible] of our possessions?
[illegible] ( ) [illegible],395 x 3,026,789=
[illegible] ( )

[illegible] the baseball game started at 3:10 p.m. and ended [illegible] p.m. How long did it take to play the game?
[illegible] ( ) 3:10 + 5:25 = ( ) 5:25-3:10= ( )N

[illegible] wheat weighs 60 pounds, how many bushels are [illegible] of wheat weighing [illegible] pounds?
[illegible] ( ) 241[illegible] ÷ 60 = ( ) 241[illegible]-2000= ( )N

[illegible] books [illegible] $4.2[illegible] [illegible] gave the clerk [illegible] $5.00
[illegible] much change should she receiv[illegible]
[illegible] ( ) $5.00-.28= ( ) $5.00-3= ( )N

[illegible] the thickness of [illegible] boards. [illegible] measured [illegible] and [illegible] other [illegible] inch [illegible]. How thick were the two [illegible] together?
[illegible]) 5/8 x [illegible] ([illegible] 5/8= ( )N

[illegible] temperature [illegible] degrees. It rose 13 [illegible] 12 a.m. How warm was it at [illegible]?
[illegible] ( ) [illegible]+13= ([illegible]-7= ( )N

[illegible] States [illegible] $25,[illegible] to support the reindeer [illegible] Only $19,[illegible] was [illegible] run the station 12 [illegible] left?
[illegible] ( ) $19[illegible]+1900=
[illegible]-19[illegible] ( )N

[illegible] of school John went [illegible] and bought 15 [illegible] How [illegible] did [illegible] articles cost?
( ) 15 x 5=) [illegible] ( )N

[illegible] ending March 28 [illegible] had [illegible] 25 [illegible] much [illegible] receive a pound [illegible]
[illegible] ( ) 4 [illegible] 28÷25= ( )N

[illegible] there [illegible] 254 books used. [illegible] is [illegible] cents. [illegible] much did all the books [illegible]
[illegible] 254 x [illegible] 254÷32= ( )N

[illegible] She paid [illegible] 2 [illegible] bars which cost [illegible] money did she have left?
[illegible] 25÷[illegible] 25-2 x [illegible] ( )N

[illegible] costs [illegible] cents [illegible] quart jar costs 40 [illegible] two pint jars of pi[illegible] cost?
[illegible] 40÷25= (40-25= ( )N

[illegible] bottle of olives costs 20 [illegible]. A 10-ounce bottle [illegible] much an ounce is [illegible] that of the olives in the [illegible]
[illegible]) 40÷10= ( ) 20÷4= ( )N

[illegible] cut up [illegible] shelf [illegible]. The shelf is [illegible] in making the shelf how much must Bob cut [illegible] feet 6 inches long?
[illegible] ft. 3 in.=
[illegible] 3 in.=
[illegible] 3 in.=

[illegible]

[illegible] 14 children [illegible] come [illegible] party, celebrating [illegible] pounds of fudge and $1\frac{1}{2}$ [illegible] The children ate [illegible] candy did they eat in all? [illegible] pounds [illegible] ( )$14+7$ ( )$6-2\frac{1}{2}$ ( )R

[illegible] Dad [illegible] his eight cylinder [illegible] car used 40 [illegible] of gasoline. How many [illegible] car? [illegible] ( )40 [illegible] ( )$712+40$ [illegible] ( )R

[illegible] of [illegible] [illegible] three hens that [illegible] their average weight. [illegible] ( ) [illegible] 12 [illegible]

[illegible] living [illegible] in 1935. [illegible] During the ten years [illegible] much larger [illegible] ( )450 [illegible] ( )1935 [illegible] 45 ( )R

[illegible] Independence was [illegible] July 4, 1776. The [illegible] signed November 11, 1918. How many years [illegible] ( )$1918-1$ [illegible] ( )1776 [illegible] ( )R

[illegible] He [illegible] 25 bushels of [illegible] $2.00 a bushel. [illegible] ( )$25x$ [illegible] ( )$25x\$1$ [illegible] ( )R

[illegible] PROCEEDING WITH

[illegible]

[illegible] choose the first number [illegible] solving the problem. Mark [illegible] the [illegible] [illegible] test.

[illegible] for some candy. [illegible] much money did [illegible] a quarter. [illegible] ( ) [illegible] ( ) [illegible] ( )R

[illegible] afternoons from [illegible] [illegible] his work. How much [illegible] ( ) [illegible] ( )$6-1$ [illegible] ( )R

[illegible] EXPERIMENTAL [illegible]

[illegible] bought [illegible] of [illegible] books for $48.00 and [illegible] cents each. [illegible] much did all the books [illegible] the company cost?

[illegible] 16 [illegible] [illegible] 25 x [illegible] = ( )N

[illegible] 25 cents [illegible] lawn. [illegible] shared [illegible] 15 cents. How much [illegible] share?

[illegible] 15 x 3 [illegible] 60 ÷ 15 = ( )N

[illegible] to sell at [illegible] flower sale. She [illegible] of 4 gladiolu[illegible]. She sold them for [illegible] each [illegible]. How much did [illegible] sell all the flowers for?

[illegible] 15 x 4 = [illegible] 56 x 15 = ( )N

[illegible] dressing costs [illegible] cents. A pint jar costs [illegible] is saved by buying a [illegible] jar instead of two [illegible]

[illegible] 49 x [illegible] = [illegible] 2 x 35 = ( )N

[illegible] a.m. [illegible] all the weeds from [illegible]. He was [illegible] 25 [illegible] an hour for his work.

[illegible] 8 - 11 = [illegible] 25 x 11 = ( )N

[illegible] pieces, one $2\frac{1}{2}$ yards [illegible] long. [illegible] the piece of lace [illegible]

[illegible] $2\frac{1}{2}$ - $1\frac{3}{4}$ = ( )N

[illegible] the normal rainfall [illegible] January is 2.45 [illegible] inches. In [illegible] year 6.12 inches of [illegible] month period [illegible] much more than the [illegible]

[illegible] 2.45 [illegible] = [illegible] 6.12 - [illegible] = ( )N

[illegible] turke[illegible] The average weight [illegible] pounds. How much [illegible] he receive for all [illegible] 25 ce[illegible] pound?

[illegible] 450 x 12 = ( )N

[illegible] 2 cents [illegible] quart costs 16 cents. [illegible] buy 1 quart th[illegible] buy 2 pints?

[illegible] 2 - 1 = ( )N

[illegible] bushels [illegible] wheat [illegible] 5 acre field. [illegible] $2.[illegible] per bushel. [illegible] much did each acre [illegible]

[illegible] 225 x [illegible] = [illegible] 225 - $2.[illegible] = ( )N

[illegible] OF [illegible]AL

[illegible] of two [illegible]icken[illegible] 30 cents [illegible] pound [illegible] one [illegible] pounds and [illegible] other [illegible]hed $3\frac{1}{2}$ pounds.

[illegible] sweet peas. [illegible] gave her mother a [illegible] sold the [illegible] for [illegible] cents a [illegible]zen. How [illegible] two flowers sh[illegible]d? [illegible] [illegible]14-[illegible] [illegible]x10 =

[illegible] a Thanksgiv[illegible] dinner averaged 60 cents [illegible] made by serv[illegible] 100 perso[illegible] at $1.00 per [illegible]

[illegible] $1.00-[illegible]0 = [illegible]

Dorey, R. E.
Evaluation of an individualized remedial program in arithmetic. . . .